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Report from DOE
Office of High Energy Physics

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Fermilab Annual Users Meeting

June 6, 2007

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An Exciting Time of Great Scientific Promise

- Production and Analysis of Tons of New Data at the highest energies.
- On the edge of something really big?
  - When, where, and how do we go through the looking glass?
- The Tevatron takes us to the door of the Terascale
- The LHC opens the door wide
  - The multi-billion dollar question: What will we see?
  - The future of high energy physics will depend on what we see…or don't see…
- Other opportunities for great science and discovery potential
  - Dark matter, dark energy, CMB, neutrinos, B decays, cosmic rays, proton decay, other precision measurements…
    - (apologies to those not mentioned)
- WE understand the stakes, excitement, and significance; but will it matter sufficiently to the global publics to continue future investments?

We are rich in advice

- NRC Study EPP2010 and its priorities
  - Terascale (LHC and ILC), Particle Astrophysics, Neutrinos, Precision Measurements
- HEPAP P5 Roadmap, now with multi-year budget guidance
- A SAG world
  - Neutrinos, Dark Matter, Dark Energy
- Subpanels
  - University, Accelerator R&D
- The intergalactic world is also an interagency world
  - AAAC, Decadal Survey

Embarking on next decade's experiments and supporting R&D activities

- NOvA
- MINERvA
- Further experiments to explore the neutrino sector
- Terascale: LHC and LHC upgrades, both detector and accelerator
- Terascale: ILC R&D and supporting SCRF
- Dark Energy Survey (with NSF): Stage III
- Dark Energy Stage IV
- Dark Matter direct detection
- Proton decay?
- Neutrinoless double beta decay?
- CP & High Intensity neutrino beams?
- (this list is not exhausted, but I am)

} DUSEL?

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Particle Physics: Planning and Prioritizing the Scientific Program

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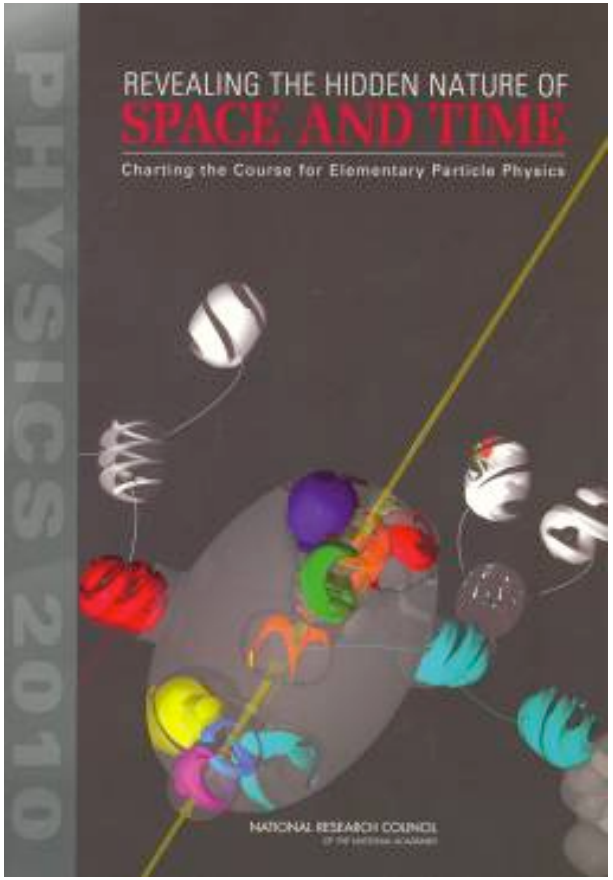

EPP2010 Charge from HEP and NSF:

- Identify, articulate, and prioritize the scientific questions and opportunities that define elementary particle physics

- Recommend a 15-year implementation plan with realistic, ordered priorities to realize these opportunities

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EPP2010 Priorities

- Terascale & LHC
  - "Fully exploit opportunities afforded by…the LHC"
- Terascale & ILC R&D
  - "Do what is necessary to mount a compelling bid…for the ILC on U.S. soil…"Central effort in U.S. plan."
- Expand Particle Astrophysics and Unification (CMB, Dark Matter, Dark Energy)
- Neutrinos and Proton Decay (internationally coordinated, staged program)
- Precision Measurements (future B Factory, lepton flavor violation and rare decays, g-2, EDM)

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HEP Budget Top Line for 2008

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	FY 2006 Actual (includes SBIR/STTR)	FY 2007 Request	FY 2007 Actual	FY 2008 Request	Percentage FY2007 Actual to FY2008 Request
HEP Base Budget	716.7	775.1	752	782.2	4.0%
Base + BES SLAC LINAC Operations Supplement*	746.1	815.1	790	843.7	6.8%

*BES Supplement completes in 2008 with B Factory Run

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FY2008 Macroeconomics

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- New (M&S-intensive) HEP construction projects will be ramping up.
  - NOvA (NUMI Off Axis Neutrino Appearance Experiment)
  - MINERVA neutrino cross section measurements
  - Daya Bay neutrino experiment w/China
  - Dark Energy Survey (Stage 3) w/NSF
- ILC R&D is ramping up to a $60M request for FY2008, up from $42M in FY2007
- The new SCRF initiative of $23.5M is synergistic with ILC R&D
- Conversion of Capital to Operating of the past decade is also over. Re-converting Operating to Capital has begun. Not an easy step.
- Running the Tevatron, B Factory, and NUMI going full steam.
- This is not a relaxed program, as we are both operating current facilities and preparing for the next decade's activities.

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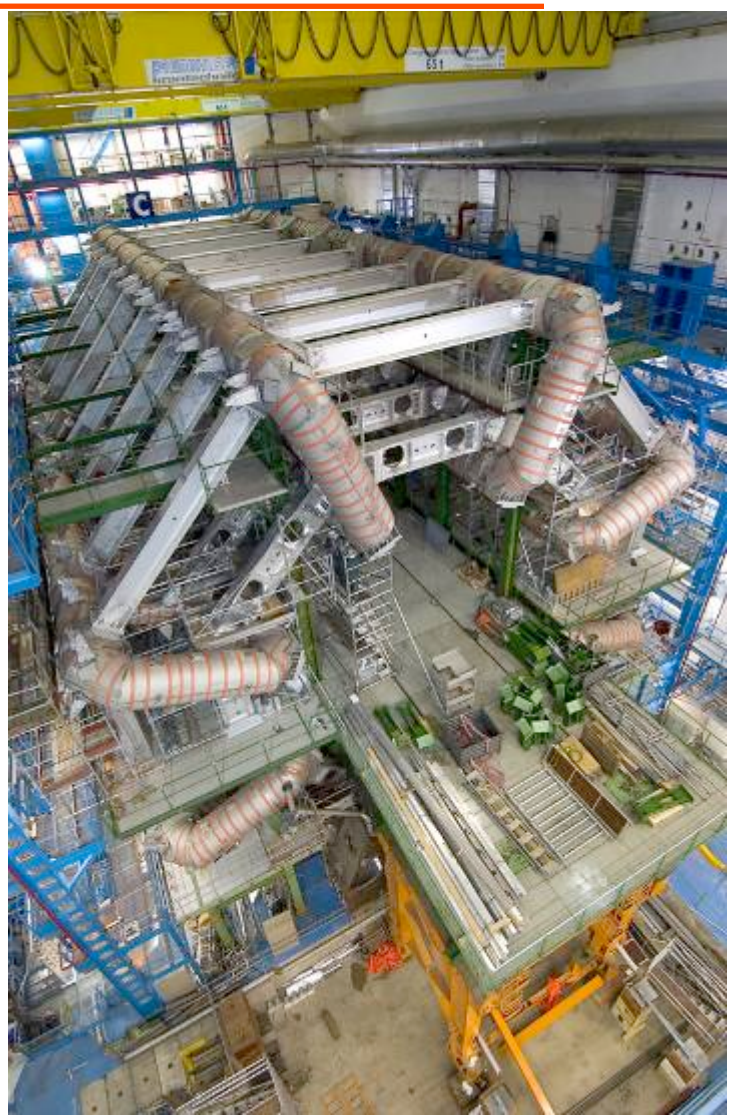
Large Hadron Collider

- The LHC physics program is a broad attack on the Terascale: the experiments should observe the Higgs boson at any feasible mass, and discover the new physics widely expected to supplant the Standard Model.
- Approximately half of the US Experimental HEP community is working on building detectors at the LHC, commissioning the accelerator and preparing software for onslaught on the science.
- DOE is funding its LHC commitments to keep up with inflation.
- University support is recognized in this context (e.g. additional travel funds for universities, and modest student and postdoc support).
- R&D and direct involvement on upgrades to maximize original investment, consistent with EPP2010 and P5 recommendations.



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ILC: High Scientific Potential and a Complex international Endeavor

- Ray Orbach at HEPAP in February 2007, restated the priority to pursue the ILC based on its scientific promise, and noted that the time to reach international agreements (site, shares, organization) and time for R&D and construction leads to a timeline realistically into the mid to late 2020s. This will be a complex international undertaking.
- We have the responsibility to assure that the US program stays healthy even with a longer ILC schedule
- Our request for FY2008 ILC R&D is $60M, up from $42M in the FY2007 budget.
- Superconducting RF R&D based at Fermilab is a key enabling technology for future applications, for ILC and more. FY2008 funding for this is $23.5M.
- DOE reiterates its interest in the possibility of hosting the ILC at Fermilab, given internationally-based affordability and scientific validation at the LHC.
- The ILC can only proceed in the context of worldwide HEP activities and commitments.
- The US will be an active participant at the ILC negotiating table.
- We congratulate the GDE for the completion of their Reference Design Report, representing the hard work of a coordinated international network of dedicated scientists and engineers.

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SCRF – A New Budget Category in 2008

- High-gradient superconducting RF will have broad applications for new scientific facilities – XFELs, ERLs, high intensity proton sources for neutrino factories, neutron sources, rare isotope studies.
- ILC a strong driver for developing new SCRF capabilities.
- R&D facilities for developing new cavity fabrication methods, surface processing, materials characterization.
- Test facilities for single cavities, cryomodules, beam injection, RF, controls, and diagnostics.
- Developing productive interactions with US industry to bring US capability to world standards.

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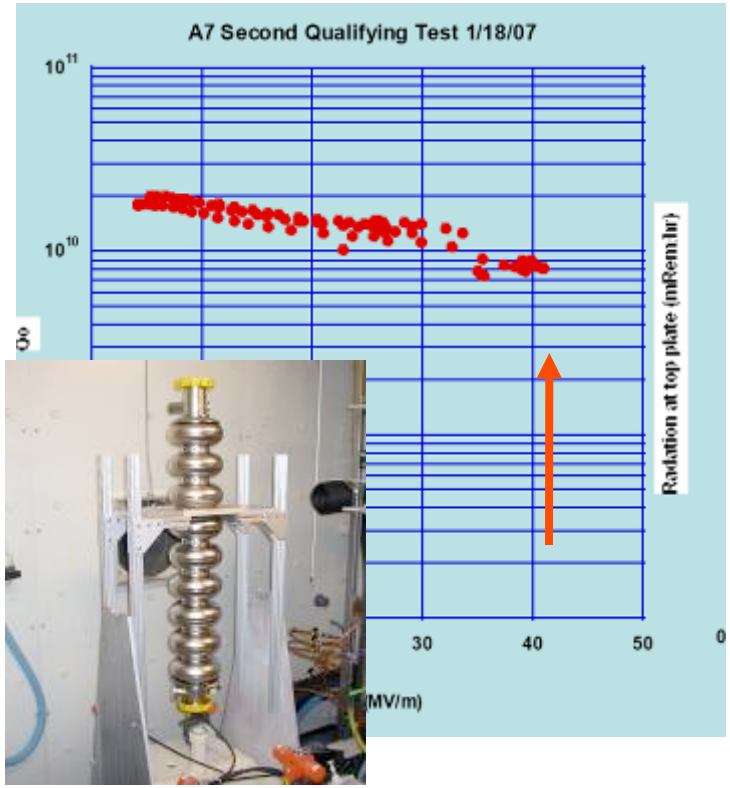
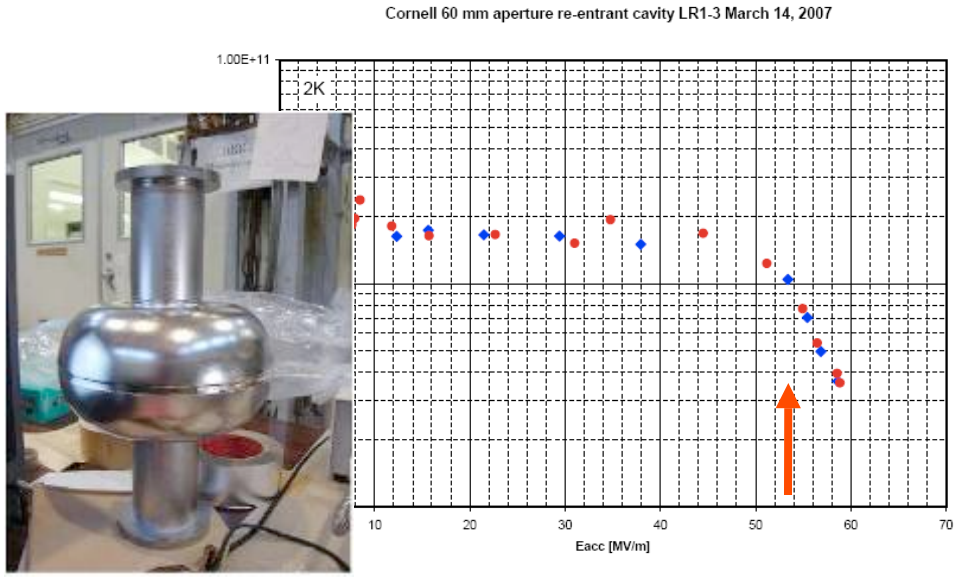
Technical Progress in SRF Cavities

The first multi-cell superconducting cavities processed in the US in JLab (manufactured in Europe) have been tested. One reached 42 MV/m and one 30 MV/m. (ILC specification is 35 MV/m for operation at 31.5 MV/m). US cavities are now under test.



A single cell cavity at Cornell reached 54 MV/m

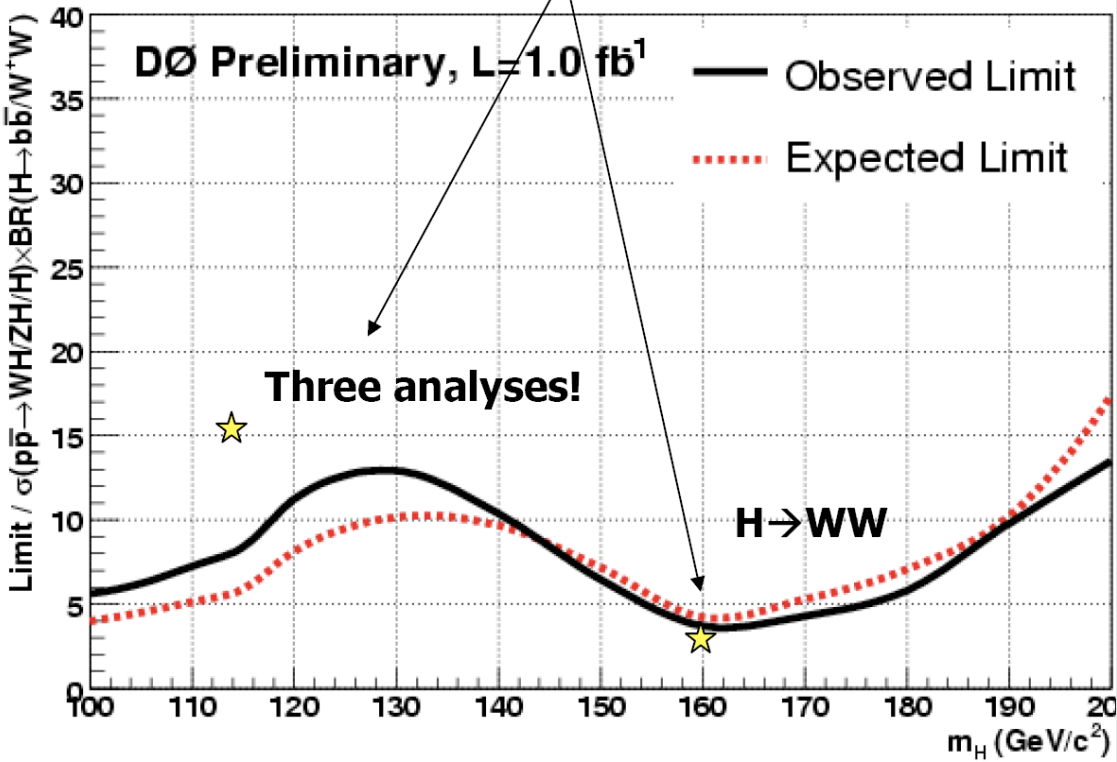


Closing in on the Higgs

Direct Tevatron searches are gaining on the SM Higgs. Individual experiments rule out signal at 5 -10 times expected cross section with 1 fb^{-1}.

With full data sample (~$8fb^{-1}$), average of experiments (not done yet) and improvements in analysis, can rule out SM Higgs if mass < 180 GeV or discover for mass < 120 GeV.

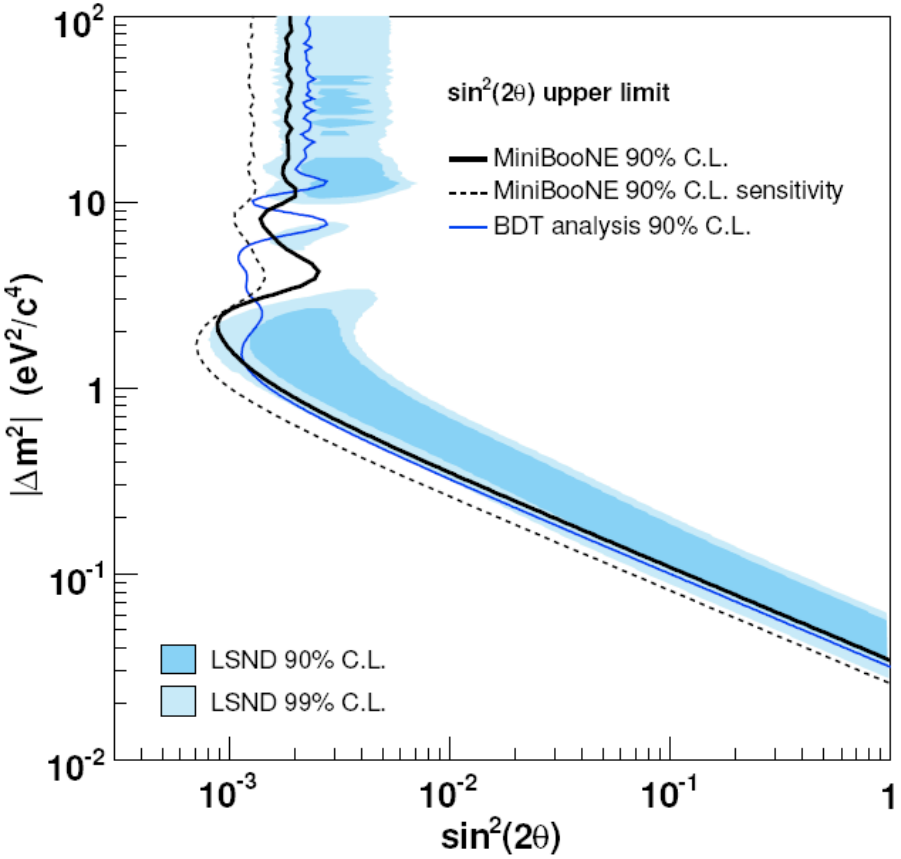
Updated DZero Combined Higgs Limits and select observed CDF measurements



Miniboone

Earlier results from LANL suggested the existence of a 4th neutrino species that does not interact with the electroweak interaction. In a long-awaited new result, the MiniBoone collaboration has ruled out this possibility, and confirms the Standard Model picture of three neutrino generations.

The MiniBoone result (black line) rules out the region to the right of the curve.



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Dark Matter Search

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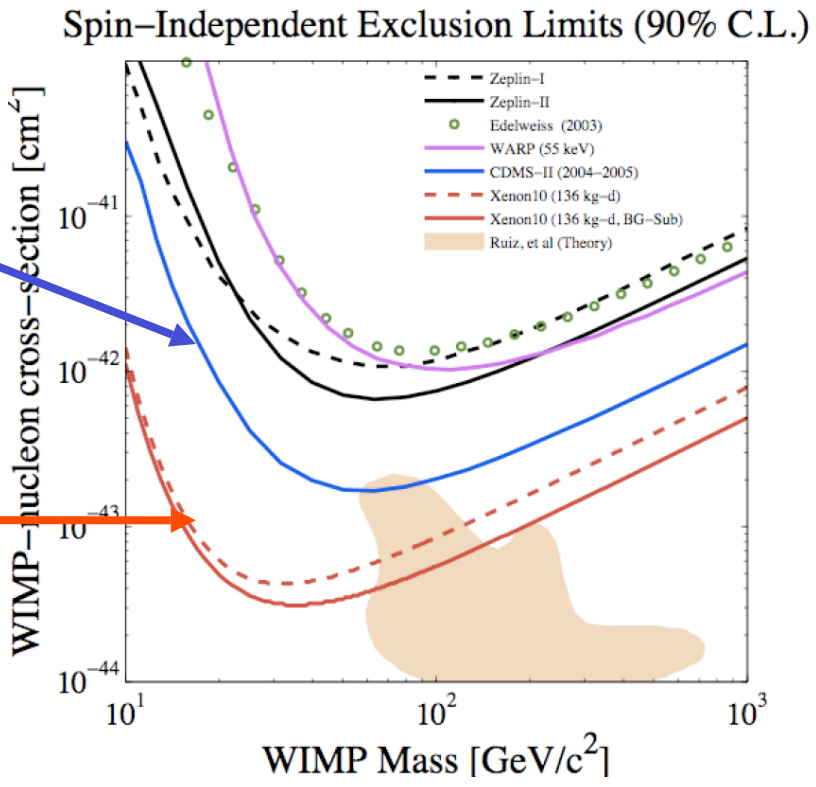
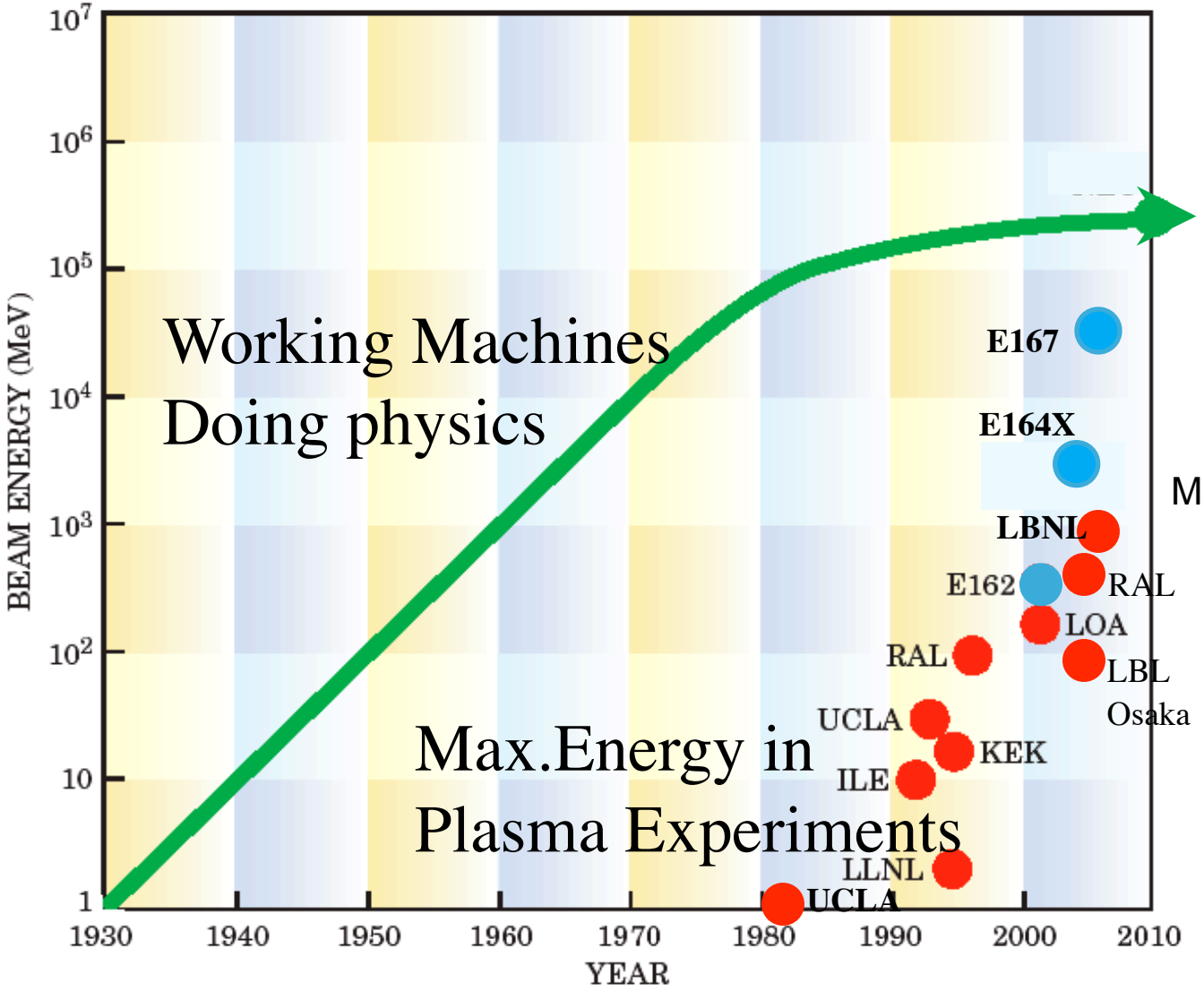
The direct search for dark matter in terrestrial experiments have been led by the CDMS experiment in a Minnesota mine. The 2005 results were the best limits on dark matter particles to date. The XENON experiment has improved these by an order of magnitude in 2006. The results expected in 2007 push into the region where supersymmetric particle dark matter WIMP candidates should exist.



Our Challenge for the Future

"Livingston Curve"



Muon colliders?

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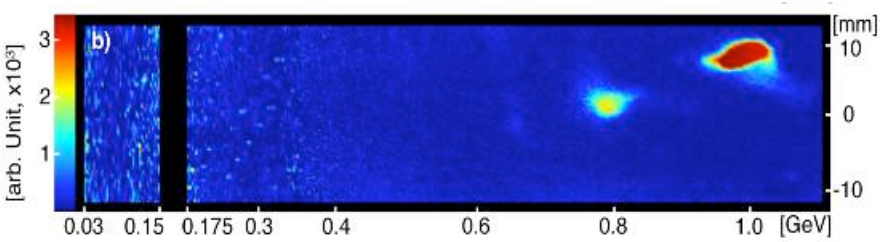
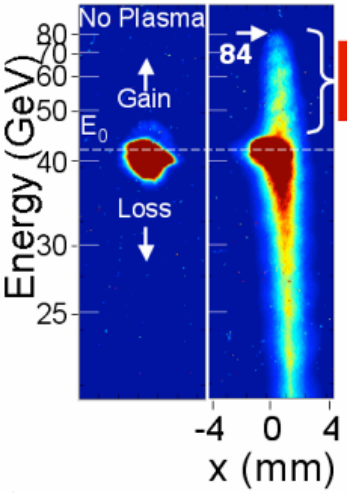
Where will next generation's accelerators come from?

- Frontier energy machines that are affordable
- Inventing lower energy machines for the broadest scientific, medical, and industrial applications
- Next step R&D efforts are getting into "real" money.
- HEP now has an advisory committee specifically for accelerator R&D strategy.





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AARD Review

- In 2006, HEPAP AARD Sub-panel highlighted the importance and contribution of AARD program to HEP and other sciences, and recommended, among others, having annual OHEP AARD program review.
- In April, 2007, OHEP AARD program review was charged to review:

  1) the suitability of OHEP's strategic plan and strategic principles in guiding AARD programs, and

  2) the balance, alignment, and quality of current AARD programs.

AARD Review – cont.

The AARD program review returned positive evaluation to both charges, especially on the increased support for LHC, ILC, and SCRF, with the following recommendations:

1) Establish effective mechanism to prune existing, add new, and enhance promising programs.

2) Structure lab-based mid-term AARD program along project lines with clear goals, approaches, deliverables, and timelines for better tracking and possible university participation.

3) Maintain strong educational components of AARD.

4) Assume the stewardship of supporting long-term AARD to extend the reach of accelerator-based research to benefit all programs in the Office of Science of DOE

Dark Energy

- The Long and Winding Road:
  - NASA and DOE are jointly sponsoring a National Academy study "Beyond Einstein Program Assessment Committee", due by Fall 2007, to advise NASA by identifying the highest priority among the five proposed NASA "Beyond Einstein" missions
  - Should this top priority be the Joint Dark Energy Mission (JDEM), DOE and NASA would propose to proceed with this mission.
  - In the interim, DOE continues to support R&D for JDEM

- DOE/HEP will also provide funding for dark energy concepts to support R&D activities that can deliver advances in key areas identified by the Dark Energy Task Force report.
  - These concepts can be near or longer-term and can be ground and/or space-based.
  - We have 32 Dark Energy R&D proposals; decisions will be announced shortly.

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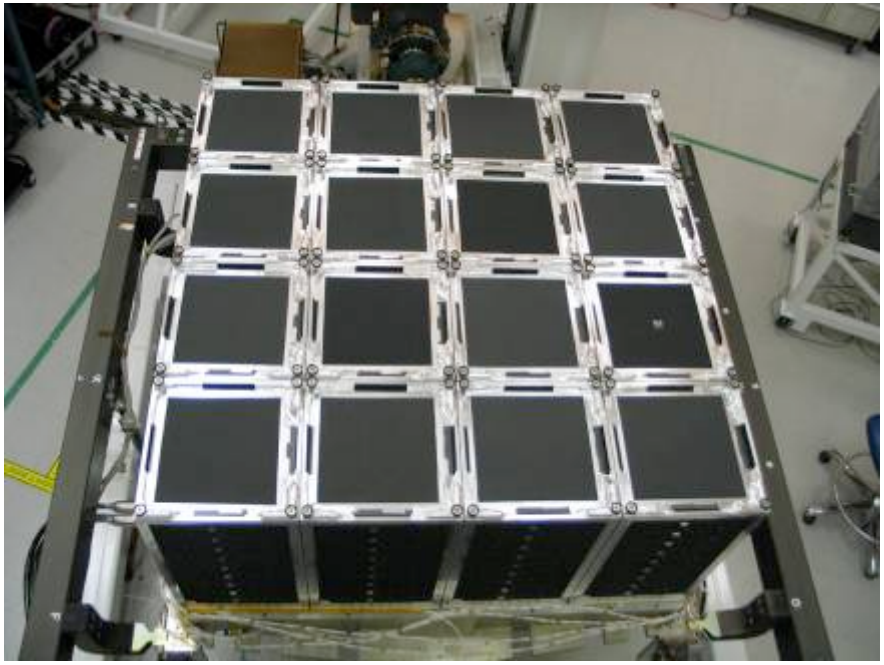
Partnership between DOE and NASA

GLAST: Observe 20 MeV to 300 GeV gamma rays in space. The primary Large Area Telescope instrument was developed under SLAC management and is now installed and under test. Launch is scheduled for Dec. 2007. (NASA and foreign agencies)



Large Area Telescope

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HEP P5 Roadmap vs. FY2008 Request

1. **Highest priority: "investigations at the energy frontier. These are the full range of activities for the LHC program and the R&D for the ILC."**

- **Support for LHC physics through university grants (~$26M) and LHC Research Program ($50M)**
- **ILC R&D request at $60M, increased support for SCRF R&D**

3. **A near-term program in dark matter and dark energy, and specific neutrino measurements: CDMS 25 kg, DES, Daya Bay. Also, support long-term R&D in these areas.**

- **Daya Bay fabrication begins in FY2008 (TPC: $29M)**
- **DES fabrication begins in FY2008* (TPC: $20M)**
- **CDMS 25kg to be considered for FY2009**
- **Long-term R&D for dark matter, dark energy, neutrinos continues**

4. **"Construction of the NOvA experiment at Fermilab along with a program of modest machine improvements."**

- **NOvA fabrication begins in FY2008 (delayed from FY2007 by CR). TPC: Not to exceed $260M. Accelerator improvements to provide additional beam power to NuMI is included in project.**

*Subject to successful review of interested agencies

Nobunaga

Hideyoshi

Ieyasu

Bird